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Converging operations and the role of perceptual and decisional influences on the perception of faces: Neural and behavioral evidence☆

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A R T I C L E I N F O

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A B S T R A C T

Theoretical analyses suggest that the regularities indicative of holistic processing can be obtained by combinations of perceptual and decisional factors. Kuefner and colleagues used electrophysiological results to suggest that the composite face effect is driven solely by perceptual factors. Two limitations of their approach are (a) it did not involve behavioral measures of perceptual sensitivity or bias, and (b) it is unclear how the measures used in that study are consistent with other measures of perceptual and decisional processing. Eight observers completed three tasks involving the stimuli used by Kuefner et al.. The first was a direct replication. The second was a complete identification task, associated with the perceptual and decisional distinctions formalized in general recognition theory. The third was an implementation of the Eriksen flanker task, which allows for a pattern of results that have been interpreted in terms of perceptual and decisional influences. While the empirical distinctions used by Kuefner et al. were not consistent with either the EEG data from the other tasks or the established behavioral measures of perceptual sensitivity and decisional bias, the inferences drawn from the EEG and behavioral data from those tasks were consistent with one another, underscoring the importance of converging operations.

1. Introduction

One of the most difficult challenges in cognitive neuroscience is providing scientifically-satisfying definitions for unobservable aspects of psychological experience. This is a problem that dates to the inception of the scientific study of psychological experience (Fechner, 1860) and is one that has seen numerous attempts at solution. In the middle of the twentieth century, "operationism" was offered as one possibility (Bridgman, 1945): it emphasized the use of a *set* of independent measurable operations, all of which point to a single conclusion, an approach that has come to be known as *converging operations*. The present study applies this approach to the concept of the holistic encoding/processing of faces, specifically as it was examined by Kuefner, Jacques, Prieto, and Rossion (2010).

We examined the presence of perceptual and decisional components underlying holistic processing using the logic of converging operations across three tasks: (a) a direct replication of Kuefner et al. (2010); (b) a complete identification task, allowing for assessment of perceptual and decisional effects as defined in both classical signal detection theory (Green & Swets, 1966) and its multidimensional generalization, general recognition theory (Ashby & Townsend, 1986); and a version of the classic flanker task, which allows for assessment of perceptual and decisional effects by way of established operational definitions (Eriksen & Eriksen, 1974). Importantly, if these three approaches are measuring the same underlying constructs—perceptual and decisional components of holistic encoding/processing—then the conclusions drawn should be consistent across the tasks. If instead these three approaches are measuring different underlying aspects of performance, then the inferences should be inconsistent. In particular, should the inferences drawn from the direct replication of Kuefner et al. (2010) be inconsistent with the inferences drawn from the other two tasks, while the inferences drawn from those two tasks be consistent with one another, it would suggest that Kuefner et al.'s measures are not assessing the same underlying constructs as are the other measures. Should this be the case, it would

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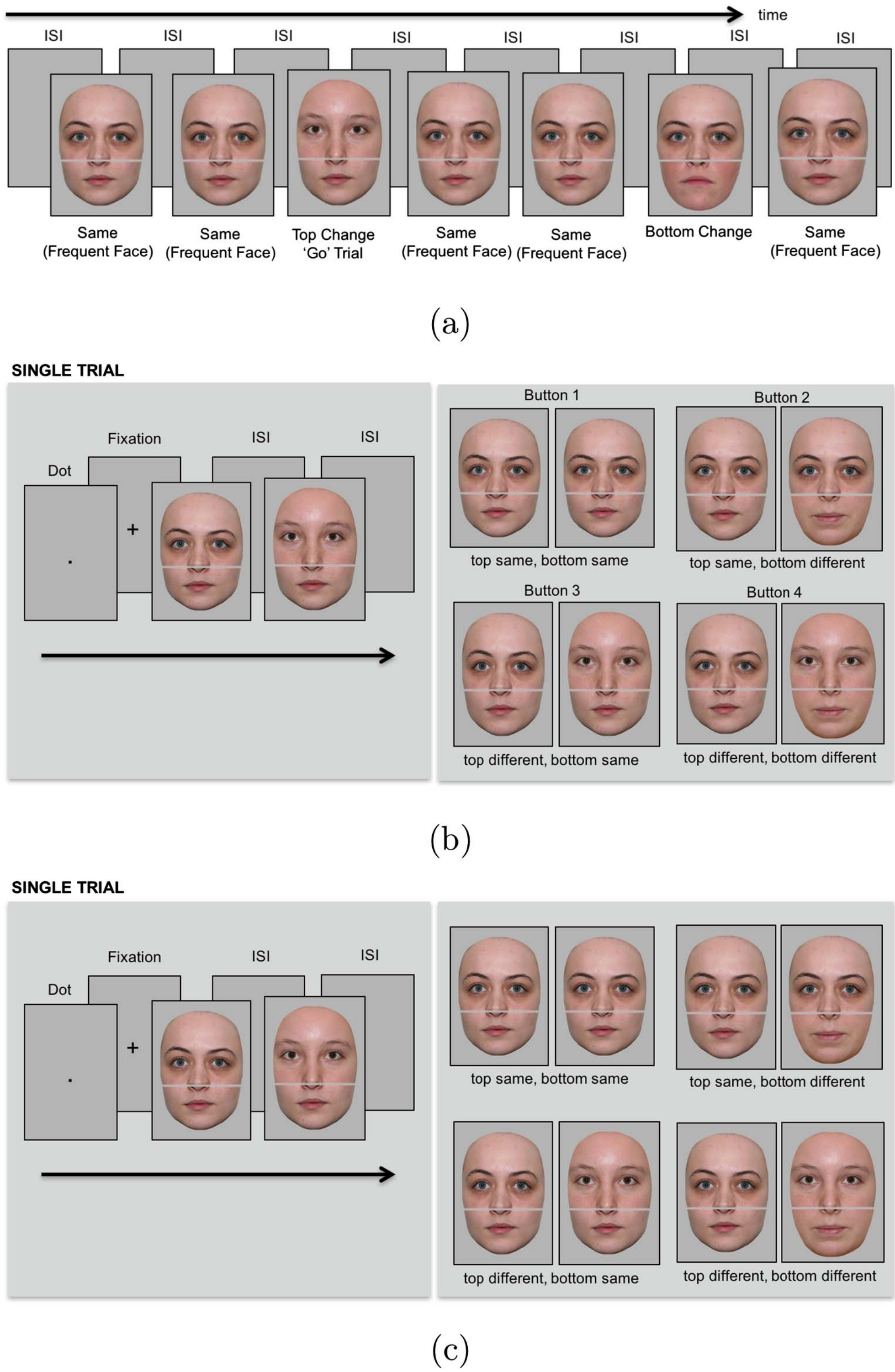

Fig. 1. Schematic representation of the procedures used in the three tasks. (a) Composite face replication task: A train of same (frequent) faces occurred 78% of the time. Different (infrequent faces) were presented 22% of the time (11% of the time with a change only in the top part of the face and 11% of the time with a change to the bottom part of the face). Participants were instructed to lift their finger only trials when the top part of the face changed relative to the frequent face. (b) Complete identification task: Two faces were presented sequentially, with the second face defined by one of four possibilities (presented with equal frequency), with each possibility assigned to a specific response. (c) Selective attention task: Two faces were presented sequentially, with the second face defined by one of four possibilities (presented with equal frequency). Participants were instructed to respond to changes in the top half of the faces for one block and the bottom half for the other. While attending to the top or bottom of the face, they were instructed to press a button with their left pointer finger if the attended part of the face was the same or with their right pointer finger if the attended part of the face was different.

further suggest that Kuefner et al.'s conclusions regarding perceptual and decisional influences are indicative of something other than those effects as they are otherwise conceptualized and measured.

1.1. Holistic encoding, the composite face task, and response bias

Of the numerous experimental approaches that have been advanced to test the hypothesis of holistic representation or processing, one that has seen consistent use is the composite face task (originally in Young, Hellawell, & Hay, 1987). The task involves the presentation of facial stimuli, typically divided in half, with the two halves coming from images of either the same or different individuals. The individuals can be either familiar or unfamiliar, the two halves can be either aligned or misaligned, and the stimulus images can be presented upright or inverted. The critical regularity in this task is an increase in the time (or decrease in the accuracy) associated with identifying one half of the stimulus when the two halves are drawn from different individuals and are aligned and upright, relative to when the two halves are either unfamiliar, misaligned, or inverted (see, e.g., Richler & Gauthier (2013) and Rossion (2013) for reviews and discussion). This is known as the